

Tetracycline protects against trabecular bone loss in ancient Nubian Populations. A. HAN<sup>1</sup>, G. J. ARMELAGOS<sup>1</sup>, K. COLLINS<sup>2</sup> and K. KOHLBACHER<sup>3</sup>. <sup>1</sup>Emory University, Atlanta, GA, 30322. <sup>2</sup>Duke University, Durham, NC 27708. <sup>3</sup>SUNY, Binghamton, NY

The occurrence of tetracycline in ancient bones has been of considerable interest. The low infectious disease prevalence has been posited as evidence of the effectiveness of this broad-spectrum antibiotic. Tetracyclines also possess non-antibiotic properties that have become a major focus of medical research. They inhibit periodontal disease and constrain the breakdown of collagen by inhibiting the action of collagenase. Tetracyclines also hinder gelatinase activity and are very effective in inhibiting matrix metalloproteinases (MMPs). The MMPs are involved in a number of the pathology of connective tissue disease such as osteoarthritis, rheumatoid arthritis, periodontal disease, osteoporosis and even cardiovascular disease.

In the NAX population (350-550 CE), we examined on age related trabecular bone loss. The decrease in ash weight (gm)/bone organ volume (cm<sup>3</sup>) is significant in female (p=.014) and not in males (p=.094). The percent of tetracycline labeled bone is significantly related to ash weight in females (p=.014), but not in males (p=.094). To determine the process that may explain these associations, histological analysis of trabecular bone loss was examined. The key element in age related loss appears to be a decrease in tensile cross member thickness. While not significant, there is a positive relationship between tetracycline level and tensile thickness in females.

Linear enamel hypoplasia in the great apes: analysis by genus and locality. D.L. HANNIBAL, University of Oregon, Eugene, OR 97403

Extensive research has been carried out on enamel hypoplasia in both historic and prehistoric human populations, with the incidence of these defects varying greatly. The incidence of enamel hypoplasia is often interpreted as a direct measure of the health status of a population, although there are likely multiple factors influencing the expression of enamel hypoplasia. Understanding the patterns of enamel hypoplasia in the primate order is essential if this trait is used to make inferences about the relationship between skeletal specimens and the environment, yet relatively few studies on enamel hypoplasia have focused on non-human

primates. These studies typically report a rather high incidence among great apes and a low incidence in most other non-human primates. It is unclear whether this difference in the incidence of enamel hypoplasia is a direct result of poor health status for the great apes or if it is differentially expressed in the great apes due to a lower threshold for expression of the trait.

The study sample includes 41 gorillas, 25 chimpanzees and 70 orangutans from the Smithsonian's National Museum of Natural History great ape collection. Analyses of frequencies of LEH are presented for both individuals and teeth by taxonomic category and locality. Overall, gorillas exhibit lower frequencies of LEH than chimpanzees and orangutans. Analysis by subspecies categories for the gorillas and orangutans shows a marked difference in frequencies of affected individuals between the mountain and lowland gorillas, but similar frequencies of affected individuals between the sumatran and bornean orangutans. Analysis by locality for the African great apes shows that chimpanzees and lowland gorillas from Gabon exhibit a lower frequency of LEH than chimpanzees and lowland gorillas from south Cameroon. Analysis by locality for the orangutans shows that orangutans from west Borneo exhibit a lower frequency of LEH than orangutans from southwest Borneo.

Taphonomic considerations in bioarchaeological research in the Mariana Islands of western Micronesia. D.B. HANSON, The Forsyth Institute, 140 Fenway, Boston, MA 02115.

The islands of the Marianas archipelago of the Western Pacific have been the focus of intensive archaeological investigations for more than 20 years. Human remains are ubiquitous components of archaeological assemblages from coastal as well as inland occupations spanning more than 1500 years. Mortuary activities in the Marianas were generally associated with habitation areas with most burials taking place in and around residential structures. Many of these structures were located on coastal margins and were thus affected by recurring storm events common to the Marianas. As a result many of the archaeological deposits on the coastal margins were extensively re-worked by the storm surges. In addition, late prehistoric mortuary programs in the Marianas included cremation and post-depositional recovery of selected human skeletal elements for ancestor worship and for tool manufacture. Utilizing two late prehistoric mortuary samples from Spain (n=62; n=250), the purpose of this paper will be to improve an overview of the taphonomic issues that arise when recovering and analyzing human remains from archaeological deposits in the Marianas impacted by storms and various cultural activities.

Sex ratio, operational sex ratio and body size dimorphism: Phylogenetic and nonphylogenetic tests of association. E.H. HARMON and C.A. LOCKWOOD, Department of Anthropology and Institute of Human Origins, Arizona State University, Tempe, AZ 85287.

Sexual selection theory, when invoked to explain body size dimorphism, states that large male body size confers an advantage in competitive interactions between males for access to females. Therefore, high degrees of agonistic behavior should correlate with significant body size dimorphism. Representative measures of intermale competition can be used to test this expectation.

This paper explores the efficacy of two measures of intermale competition among anthropoids—sex ratio (SR) and operational sex ratio (OSR)—expanding upon the recent work of Mitani et al. (1996). Additionally, it examines phylogeny as a potentially confounding factor in the relationship between these traits and body size dimorphism.

Mitani et al. (1996) demonstrated a significant correlation between OSR and body size dimorphism in polygynous anthropoids by comparing residuals of independent contrasts between OSR and female body weight with residuals of independent contrasts between male and female body weight. When analyzed using the same methods, data and phylogeny, we show that SR also shows a significant correlation with body size dimorphism ( $r = .52$ ;  $p = .03$ ). However, standard regressions (i.e., not controlled for phylogeny) of OSR and SR with residual sexual dimorphism were not significant. These results differ somewhat when alternate weight estimates or measures of dimorphism were employed.

The disjunct between independent contrasts and nonphylogenetic regression analysis is noteworthy, and occurs because species inconsistent with the predicted relationship tend to be closely related. Taking phylogeny into account gives less weight to these cases. As expected, when phylogeny is accounted for, OSR is a good predictor of intermale competition. This analysis reveals that SR is also an adequate predictor, but unlike OSR, SR data are readily available for many species.

Tissue contributions to intergroup differences in human deciduous molar crown sizes. E.F. HARRIS, University of Tennessee, Memphis, TN 38063.

This study describes size of constituent tooth crown components—enamel, dentine, and pulp—to address the manner in which males characteristically have larger teeth than females and the observation that teeth of American blacks are larger than those of American whites. Measurements were collected ( $n = 333$  individuals) from bitewing radiographs with a computer-aided technique. Tissue thicknesses (enamel, dentine, pulp) were measured at the height of contour of the crown normal to the tooth's long axis. None of the variables showed significant

deviations for g1 or g2. Deciduous molars are composed of about 1/7 enamel, 1/3 dentine, and 1/2 pulp. Marginal enamel and dentine are thicker on the distal aspects of these molars. Hard tissue thicknesses also are greater on the more-molariform m2 than m1. Details differ by tooth type, but males typically have larger dentine and pulp dimensions than females, and there is no sexual dimorphism in marginal enamel widths. Males scale isometrically with females for all variables tested here. Blacks exceed whites in size of all tissues, but tissue types scale isometrically with blacks and whites with one exception: enamel thickness is disproportionately thick in blacks; while the absolute difference is small (5.56 mm in blacks summed over all four molars versus 5.04 mm in whites), the statistical difference is considerable ( $P < 0.0001$ ). Aside from enamel, crown size in blacks is increased proportionately vis-à-vis whites. Principal components analysis confirmed these univariate relationships and emphasized the statistical independence of crown component thicknesses, which is in keeping with the sequential growth and separate origins of the tissues contributing to a tooth crown. These findings direct attention to the rates of enamel and dentine deposition of which nothing is known—since it appears that blacks (with larger crowns) probably spend less time in tooth formation than whites.

Primate biogeography and ecology on the Sunda Shelf islands: A paleontological and zooarchaeological perspective. T. HARRISON and J.S. KRIGBAUM, Department of Anthropology, New York University, New York, NY 10003.

A review of the primate faunas from paleontological and archaeological sites in Borneo, Sumatra, and Java provides a diachronic perspective on the biogeography and ecology of the Sunda Shelf islands. The primates of Sundaland are of particular interest for several reasons: (1) they represent a significant component of the modern-day fauna, (2) they provide insights into prehistoric human hunting strategies and dietary preferences, and (3) they offer clues to understanding paleoecological changes during the late Quaternary.

A combination of the effects of ecological change, human hunting, and habitat disturbance have contributed to the current biogeographic distribution of primates on the Sunda Shelf islands. Although there appear to have been few island extinctions (*Hylobates syndactylus* and *Pongo pygmaeus* became extinct on Java), climatic perturbations and the arrival of modern humans during the later Pleistocene impacted on the primate faunas, at least at the local level, with differential effects. Zooarchaeological evidence indicates that primates were extensively exploited for food by humans. However, the relatively low density of humans on Sundaland in the late Pleistocene and early Holocene, with their limited pre-Neolithic technologies for hunting arboreal mammals, is consistent with the fact that humans appear to have had little impact on primate distribution, except at the local level. A more important factor seems to have been ecological change caused by climatic and eustatic fluctuations during the later Pleistocene.

Most significantly, during the Last Glacial Maximum (~20-18 ka) the climate of Southeast Asia was cooler and precipitation was reduced and more seasonally distributed, with tropical rainforest giving way to drier woodlands. This had a significant impact on the structure of the mammalian

community, especially the large herbivores and their dependent carnivore guild. Reduction in the availability of tropical forest at this time would also have had profound implications for primate distributions. A further consequence of the cooling trend during the Last Glacial Maximum is reflected in the relatively larger dental size (and presumably body size) of many of the fossil and subfossil primates in accordance with Bergmann's rule.

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The impact of maternal lineage on intracortical remodeling in the rhesus macaque femur. L.M. Havill, Dept. of Anthropology, Indiana University, Bloomington, IN 47405.

Bone morphology, both grossly and microscopically, results from a combination of genetic and environmental factors (Bouvier 1985, Lanyon 1989), but we do not yet understand how these factors interact with one another. What is the relative importance of each? To what degree does one's genetic make-up mediate environmental effects? Although age, sex, disease, nutrition, and habitual strains have all been identified as factors influencing intracortical bone turnover, much of the accumulated variation among individuals remains unexplained and may be due to genetic regulation.

Evaluation of the amount of remodeled cortex among rhesus macaques of different maternal lineages may allow for quantification of the contribution of maternal lineage to the microstructural product. The results presented here stem from an analysis of femur cross-sections taken from 88 rhesus macaque skeletons curated at the Caribbean Primate Research Center, San Juan, PR. Maternal lineage, body weight, sex and age are analyzed as covariates to reveal their relative effects on osteonal bone. In addition, heritability is estimated using mother-offspring and sibling pairs.

Through studies such as this one, we can increase the value of skeletal microstructure as an investigative technique to complement what we can learn grossly from the skeleton. A comprehensive understanding of the factors resulting in osteonal bone, and their interaction with one another is very important to anthropologists striving to accurately interpret the microstructure of deceased individuals.

Growth patterns of human enamel analyzed by confocal microscopy. R. HAYDENBLIT, P. SMITH and B. PODBILEWICZ\*. Laboratory of BioAnthropology and Ancient DNA, The Hebrew University-Hadassah School of Dental Medicine, Jerusalem, \*Department of Biology, Technion-Israel Institute of Technology, Haifa, Israel.

Comparative cellular and genetic analyses of developmental processes are likely to contribute to the understanding of the mechanisms governing organ

formation. Although the overall processes of tooth development as well as enamel formation in hominids appear to be relatively well understood, the mechanisms that determine the final tooth size and shape on the one hand, and enamel thickness, on the other, still need to be explored. Enamel prism packing patterns reflect the past history of ameloblasts providing information about growth patterns in tooth development. We measured area and density of enamel prisms on the cuspal surface of human molar teeth to examine if the onset and rate of enamel apposition differs according to tooth size, and/or cusp type. The study was based on confocal laser scanning microscopy (CLSM) images collected from the mesiobuccal (MB) and distal (D) cusp tips of 20 mandibular first permanent molars. Prism measurements followed published methods (Fosse, 1968; Grine et al., 1987). Mean area (in  $\mu\text{m}^2$ ) of prisms on the MB cusp was  $33.90 \pm 6.15$  (S.D.) and  $30.99 \pm 5.39$  on the D cusp. Differences in prism area between cusps was significant ( $p < 0.02$ ). Prism density (prisms/ $\text{mm}^2$ ) was significantly smaller on the MB cusp ( $23805 \pm 4760$  (S.D.)) than the D cusp ( $26331 \pm 4993$  (S.D.)) ( $p < 0.02$ ). Furthermore, there was a significant difference between small and large teeth on the MB and D cusps. We suggest that the marked difference in prism parameters between the two cusps results in the larger size of the mesiobuccal cusp which is correlated to a large prism area with less densely packed prisms. Thus, MB is larger to D cusp due to an increase in the ameloblast secretory area. The method provides a three-dimensional, non-destructive analysis to study evolutionary growth and developmental processes in mineralized tissues of modern teeth. Furthermore, it will enable us to test current concepts on the ontogeny and phylogeny of the hominid dentition by integrating data on tooth size and microstructure. This study was supported by grants from the Israel Science Foundation.

Replacement versus continuity in the prehistoric North American Arctic as assessed by ancient mtDNA. M.G. HAYES and D.H. O'ROURKE, Laboratory of Biological Anthropology, University of Utah, Salt Lake City, UT 84112.

Sharp transitions in the archaeological record are often hypothesized to represent either population replacement or cultural diffusion events. Two regions of the North American Arctic provide an opportunity to test these alternative hypotheses. In the Eastern Canadian Arctic there is a rapid displacement of the Paleo-Eskimo Dorset culture by the Neo-Eskimo Thule culture ca. 1000BP, although pre- and post-transition skeletal populations appear similar. In the Aleutian Islands, the inhabitants are characterized as dolichocranic prior to 1000BP (Paleo-Aleut), after which they are described as brachyranic (Neo-Aleut) but are associated with continuity in cultural remains over the past 4000BP. To test if population replacement is a plausible scenario to explain either of these patterns, pre- and post-transition individuals were examined genetically.

mtDNA was extracted from archaeologically recovered rib samples from three sites in the Aleutian Islands and six sites in the Hudson Bay vicinity. Six regions of the mtDNA genome containing polymorphic restriction site or length markers, which define a maximum of five aboriginal haplogroups, were PCR amplified and scored on electrophoretic gels. Analysis of marker frequencies shared across the morphological transition are indicative of continuity in the Aleutian Islands. In the Eastern Canadian Arctic, possible evidence for a population replacement is evident. Preliminary mtDNA HVSI sequences concur with these data.

Permission to sample skeletal populations was afforded by the Inuit Heritage Trust and Aleut Corporation. This research was funded by the National Science Foundation and Wenner Gren Foundation.

Morphometric analysis of orbitotemporal angulation and the evolution of postorbital processes and bars in therian mammals. CHRISTOPHER PAUL HEESY, Doctoral Program in Anthropological Sciences, State University of New York at Stony Brook, Stony Brook, NY 11794

High orbital convergence, like that found in primates, small-bodied felids and herpestids, results in the temporalis fascia being placed laterally adjacent to the lateral wall of the orbital cone. Cartmill hypothesized that postorbital processes and bars in taxa with convergent (forward-facing) orbits function to prevent the temporalis fascia and muscle from encroaching on the orbital contents and disrupting oculomotor coordination during mastication. Cartmill's hypothesis predicts that increases in orbital convergence are correlated with increases in the relative size of postorbital processes, the precursors to complete postorbital bars. However, many mammals with postorbital bars, such as scandentians, neoselenodont artiodactyls and equids, have divergent orbits, and are therefore not directly explained by Cartmill's hypothesis.

This study investigated the relationship between orbit orientation relative to the temporal fossa and postorbital bar morphology. Three-dimensional coordinate data were collected on specimens from ten orders of mammals including taxa with confluent orbitotemporal fossae, postorbital processes and complete postorbital bars. These data were transformed into angular measurements of orbital convergence, frontation, orbitotemporal angle (a measure of the relative orientation of the orbital aperture and temporal fossa), postorbital process size, and postorbital gap length (estimating postorbital ligament length).

The planes of the orbital and temporal fossae are less coplanar in taxa with large postorbital processes and complete bars. Orbitotemporal angle is correlated with relative postorbital gap length in taxa with incomplete bars. Convergence is highly correlated with orbitotemporal angle for carnivorans, and frontation is highly correlated with orbitotemporal angle for all taxa. These results corroborate Cartmill's hypothesis that shifts

of the orbit out of the plane of the temporalis fascia are correlated with the evolution of postorbital processes and bars.

Growth discordance as a risk factor for asthma in young children. K.B. HELD, Department of Anthropology, University of Oklahoma, OK 73019

Recent studies indicate obesity often precedes asthma both in women and in children (Camargo et al. 1998 and 1999). The relationship between body size and asthma is more complex for the youngest children. Contingency tables demonstrate that (1) children 4 to 7 years are at high risk for asthma if their current body mass index (BMI) is discordant with their birthweight; (2) maternal obesity predicts asthma in these young children; and (3) maternal BMI correlates most strongly with asthma in young children who were small at birth.

Questionnaire data on 2899 children aged 4 to 7 years were analyzed from the Third National Health and Nutrition Examination Survey (NHANES III), 1988-94. BMI-for-age of children, their birthweights, and BMI of their mothers were sectioned into quartiles.

Although neither birthweight nor current BMI-for-age of children alone predicts asthma, current BMI-for-age in quartiles predicts strongly for children whose birthweight was in the smallest quartile (2.17, 4.23, 9.64, 13.49% asthmatic;  $p=0.050$ ). That is, children whose weight now puts them into the highest quartile are 6.22 times more likely to have asthma as are those who remained in the smallest quartile. Conversely, children who were large at birth bear greatest risk if their current BMI is low (19.35% of smallest children vs. 9.20% of largest children large at birth are asthmatic).

Asthma in children demonstrates a clear dose-response relationship with successively higher maternal BMI quartiles. From lowest to highest maternal BMI quartile, percent children with asthma are 6.3, 7.5, 9.6, and 11.2 ( $p=0.008$ ).

Correlation of asthma with maternal BMI quartiles is strongest for infants in the lowest birthweight quartile (4.25, 9.94, 12.87, 14.74%;  $p=0.004$ ). Small babies of very large mothers have extremely high risk. Among children born into the smallest birthweight quartile, 26.7% of those whose mothers have BMI > 40 are asthmatic.

Growing evidence indicates that asthma follows the same pattern as other diseases of modernization of increasing risk with increasing overnutrition and overweight. Risk for the youngest children is strongest among those whose growth deviates from their birthweight or the size of their mother.

Extractive foraging behavior and brain evolution in large-brained mammalian lineages, with special emphasis on primates and the genus *Homo*. J.A. HELLER, Department of Anthropology, University of New Mexico, Albuquerque, NM 87131

It is often said that, among mammals, (1) bipedal locomotion and (2) very large brains are the most distinctive



morphological features of the genus *Homo*. Although they are usually studied separately, these complexes are quite interdependent in function. Bipedalism frees the hands for manipulation of a variety of useful objects, including food items and the tools used to procure and process them. Such manipulations may require a more powerful brain than that found in most mammals. While it is true that the evolution of bipedalism preceded significant brain size increase in hominids, brain size/complexity and control of resources (via tool use) have clearly coevolved in some fashion. Many details of this coevolution remain to be illuminated.

'Machiavellian' intelligence has been favored as an explanation for the evolution of relatively large brains among primates in general. However, our current state of knowledge does not allow disproof of the hypothesis that many of the *same* cognitive processes involved in social manipulation of conspecifics may *also* be involved in physical manipulation of food items and tools.

Furthermore, certain similarities among large-brained, large-bodied, highly social mammalian lineages bear on this issue, yet they have received little attention from anthropologists. Notably, primates, cetaceans and proboscideans all possess specialized organs for locating, gaining access to and manipulating food/water. These are the hand, sonar and trunk respectively, used routinely by these animals to find and extract unseen critical resources.

Elephants and some primates 'know' to dig for water in dry streambeds, an extractive behavior. Dolphins, like chimpanzees and humans, hunt cooperatively on a regular basis. Hunting and fishing may be thought of as extractive subsistence activities in the sense that that prey animals must first be located, then forced out of their adaptive zone (a tree, a herd, a burrow, the open ocean, the sky) into the physical control of the hunter. Evidence for a connection between extractive foraging, broadly defined, and brain evolution in all three mammalian lineages is explored.

Effects of food type and distribution on feeding competition in sifakas. C.A. HEMINGWAY, Duke University, Durham, N.C. 27708

Variation in spatial and temporal distribution of foods is expected to influence the type and intensity of feeding competition among individuals within a social group. I tested predictions regarding the effects of resource distribution and additional resource characteristics on within-group feeding competition in Milne-Edwards' sifakas, inhabiting the southeastern rainforests of Ranomafana National Park, Madagascar. I assessed two levels of feeding competition: high intensity conflicts and low intensity supplants.

Here I provide evidence that a frugivorous-folivorous species utilizes different behavioral modes when competing over different types of food. As expected, food items considered monopolizable such as seeds and whole fruit were contested via high intensity conflicts more often than items widely dispersed and therefore less monopolizable. In contrast, low intensity supplants occurred more frequently than expected over leaf sources, and less frequently over fruit and seed sources. Foods eliciting high rates of agonism were more clumped in spatial and temporal distribution than those eliciting low rates of agonism. As tree size and temporal

availability increased, feeding agonism over particular food items decreased. As tree species density and spatial clumpedness increased, feeding agonism over a given plant species decreased. The majority of these results accord well with feeding competition theory. However, contrary to expectations, food types (leaves, seeds and fruit) did not differ in spatial or temporal distribution. Most resources used by sifakas, regardless of food type, are generally spatially clumped and moderately available in terms of temporal dispersion.

This study illustrates that although feeding competition predictions may be met, an underlying assumption regarding the relationship between food type and distribution is violated in this case. Resource distribution figures prominently in models of primate social organization and yet, determining which plant characteristics make foods monopolizable remains difficult to assess across taxa.

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Are the mummies of Late Bronze/Early Iron Age Xinjiang (China) Indo-European invaders from the Russian steppes? BE HEMPHILL, Department of Sociology & Anthropology, California State University- Bakersfield, Bakersfield, CA 93311.

Human occupation of the Tarim Basin of Xinjiang (western China) prior to the mid-Iron Age (c. A.D. 500) remained unknown until the 1970s. During the next two decades a startling series of Late Bronze/Early Iron Age sites were discovered. Perhaps most stunning of all was the discovery of mummies and skeletal remains identified as non-Han Chinese "Caucasoids." The sudden emergence and non-Chinese appearance of Tarim Basin inhabitants immediately led to speculation as to where this population may have come from. The most popular view sees these remains as those of Indo-European speakers whose origins may be traced to pastoralist populations of the Russian steppe.

Eight cranial measurements from 25 Aeneolithic, Bronze Age, and Iron Age samples, encompassing 1353 adults from the Russian steppe, China, south-central Asia, Iran, and the Indus Valley were compared to test whether these inhabitants of the Tarim Basin uniformly exhibit closest phenetic affinities to Late Bronze populations of the Russian steppe. Differences between samples were compared with Mahalanobis generalized distance ( $d^2$ ) and patterns of phenetic affinity were assessed with two types of cluster analysis, multidimensional scaling, and principal coordinates analysis.

Results indicate that Tarim Basin populations do not owe their origins to pastoralist populations of the Russian steppe. Rather, Tarim Basin origins appear more complex. The earliest inhabitants are not only strongly divergent from later inhabitants, but exhibit closest affinities to populations from the Indus Valley. By contrast, later Tarim Basin populations exhibit affinities to inhabitants of the Oxus River valley of south-central Asia.

Human skin color as a measure of time in situ. M. HENNEBERG, University of Adelaide, Adelaide 5005 Australia and C.L. BRACE, University of Michigan, Ann Arbor 48109

The color of human skin is a highly heritable, adaptive characteristics. It shows covariance with the intensity of solar UV radiation in populations who resided in the same geographic areas for a long time. The length of time in situ required to elicit full response of skin color to UV radiation levels in terms of the operation of directional forces of evolution is unknown. It can be estimated from comparisons of skin color in geographical areas of similar UV intensity, but clearly differing in the time of human settlement. Despite its role in classification of human variation, skin color was not frequently measured quantitatively in a uniform way thus making generalisations and some comparisons difficult. Besides the most reliable EEL method, relatively large number of observations was made using von Luschan's scale (VL). Using data on 110 populations for which both EEL readings and VL assessments were available a linear relationship between the two scales was found:  $EEL=87-2VL$ ,  $r=0.95$ . This allowed use of a large skin color VL dataset of J. Birdsell covering all regions of Australia where a NW-SE cline in skin color exists. The comparison of the pigmentation in Australian and South African native populations living at similar geographic latitudes allows estimation of the rate of lightening of the skin color. Assuming that settlement of Australia from the North began 60Ka ago while Africans evolved in situ into anatomically modern form, it can be estimated that the increase in skin reflectance occurs at the rate of approx. 0.22% (EEL) per 1000 years. With this rate it would take people entering Europe 173 Ka to increase reflectance from Central African approx. 27% to 65% observed in Northern Europe. This time is well outside the frame of the "replacement" of the Neandertals. It is suggested that the loss of pigmentation is a consequence of the probable mutation effect. Skin darkening rate under natural selection, as indicated by American populations, is faster.

Dental health of slaves from the cemetery of Ponte di Ferro near ancient Poseidonia (Paestum) in Italy, 6th-4th c BCE. Living conditions or fluorosis? R.J. HENNEBERG, Anatomical Sciences, University of Adelaide, Adelaide 5005, Australia, and G. AVAGLIANO, Museo Archeologico di Paestum, 84063 Paestum (SA), Italy.

High levels of fluoride in drinking water in some parts of Italy often make it difficult to interpret frequencies of hypoplasia and caries found in archaeological dental samples. An attempt is made to evaluate the influence of living conditions upon the dentition of slaves from the cemetery of Ponte di Ferro, near Greek Poseidonia where drinking water may have contained high levels of fluoride.

The cemetery of Ponte di Ferro, located 850m from the city walls in a coastal dune consisted of Greek style burials. Very poor grave goods or lack of them suggested low social status of the buried people.

Total number of 2020 permanent teeth of 98 individuals (59 females, 34 males and 5 subadults) were examined. The average age of adults was 41.4 years (F = 41.8, M = 40.6 years). Linear hypoplasia was present in all individuals (100%) with preserved tooth crowns and 90.5% of them had 3 or more rings (F = 91.2%, M = 93.9%, and S = 60%). Males had on average 4.1 rings, females 3.9 rings and subadults had 3.8 rings on canines. Pitting occurred on some teeth of 51.5% individuals. Mottled enamel was found among 9.3% individuals and brown patches on enamel were found among 21.6% of individuals. Caries affected 83.7% of individuals (F = 86.4%, M = 85.3 %, S = 40%). Frequency of carious teeth in the sample was 19.2% (21.3% in females, 16.5% in males, and 15.6% in subadults, and the difference between females and males was statistically significant). In addition 3.5% of teeth were lost before death (F = 4.5%, M = 2.2%) most probably due to caries. The average tooth wear (Scott's scale) in adults was 19.4 and there was no statistically significant difference between sexes.

The teeth from Ponte di Ferro were compared with the teeth of citizens and professional soldiers from a coeval wealthy city of Poseidonia and with dental samples from areas with high contents of fluoride in drinking water.

While frequencies of pitting, mottling and brown stain on teeth in Ponte di Ferro were similar to those in the sample from urban Poseidonia, the frequency of hypoplasia, the average number of hypoplastic rings on canines and the frequency of carious teeth were higher in Ponte di Ferro.

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Growth and sexual dimorphism in orang-utan crania: a three-dimensional approach. S.M.HENS, Johns Hopkins Univ. School of Medicine, Baltimore, MD.

Traditionally, sexual dimorphism has been studied in comparisons between adult forms. However, new insights may be gleaned by using an ontogenetic approach to these investigations. Although growth and sexual dimorphism have been previously examined in the orang-utan, this study uses a three-dimensional (3-D) morphometric approach useful for clarifying both local and global form differences.

3-D coordinate data was collected for 32 landmarks on 100 orang-utan crania divided into infant, juvenile and adult developmental stages. Data were subdivided into four regions: face, basicranium, neurocranium, and palate; and analyzed using Euclidean Distance Matrix Analysis (EDMA). EDM is a registration-free method for comparing forms quantitatively in 3-D space by analyzing all possible linear distances between biological landmarks.

Results indicated that growth in the face and palate was most similar between the sexes especially in the youngest

age ranges. This corresponds primarily to an increase in height and length of the maxilla to accommodate the developing dentitions. However, differences between the sexes were noted at the earliest developmental ages in the neurocranium and cranial base. Growth in the frontal region in males preceded that seen in females and overall increases in magnitude were observed in older males, while adult females experienced increases in magnitude primarily in the temporal fossae. In the basicranium, females develop early in the width of the base, while males increase in the length of the base. Also, in later developmental stages, males continue to increase in size while female growth remains more or less constant.

Architecture of trabecular bone and mechanical loading in the skull. S.W. HERRING, S. TENG and Z.J. LIU, Orthodontics, Univ. of Washington, Seattle, WA 98195.

Among many original applications of physical and mathematical methods to morphology, Charles Oxnard pioneered the use of optical imaging techniques for examining bony architecture. Modern computers can apply such techniques to quantify the internal structure of living, dead, or fossilized bones. Because the bony trabeculae give information about directional strength and stiffness, such analyses shed light on functional loading patterns.

We examined trabecular architecture, mechanical properties, and *in vivo* strains of the jaw joint region in the pig, *Sus scrofa*. For architecture, mandibular condyles and zygomatic arches were thick-sectioned in three planes and imaged. Trabecular morphology was quantified stereologically (Turner et al., 1990) or with an edge-tracing algorithm (Rensberger, pers. comm.). For mechanical properties, condyles were cut into rectangular cubes and loaded in compression. *In vivo* strain measurements were made from miniature pigs during mastication and muscle stimulation. Stacked rosette strain gages were affixed to the zygomatic arch just lateral to the articular eminence and to the lateral surface of the condylar neck.

Trabeculae in the condyle were dense and oriented vertically, perpendicular to the occlusal plane, with a secondary anteroposterior component. Correspondingly, condylar bone was stiffest and strongest in the vertical direction and weakest mediolaterally. During function, predominant compression in the vertical direction was measured in the condylar neck. Thus the condyle appears to receive an axial compressive load. In contrast, the articular eminence featured less dense trabeculae mainly oriented mediolaterally. *In vivo* strain lateral to the eminence was tensile in the vertical direction. These results suggest that the eminence is subjected to bending rather than axial compression.

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Disease-Specific Mortality among Infants at the Erie County Almshouse, 1880-1899. R. L. HIGGINS, Department of Health Sciences, Cleveland State University, Cleveland, OH 44115-2407.

The Mortality Register for the Erie County Almshouse (Buffalo, N.Y.) was examined to determine patterns of disease-specific mortality among infants during the period of 1880-1899. This study focused on differences between infants who were born at the Almshouse and those who were admitted shortly after birth as well as differences in neonatal and post neonatal mortality.

Data were transcribed into machine-readable form and checked twice for accuracy. A total of 536 records were complete with regard to age, sex, nativity and date and cause of death.

During the period of 1880-1889, 74% of the infants listed were native-born (but born outside of the Almshouse), 23% had been born at the Almshouse and three percent were foreign-born. During the next decade 97% were native-born, three percent had been born at the Almshouse and none were foreign born.

There were 129 neonatal deaths between 1880-1899. The leading cause of death for this group was starvation, followed by gastrointestinal infections, premature birth, and respiratory infections. Starvation was also the leading cause of post neonatal death ( $N = 407$ ), followed by gastrointestinal infections, convulsions, respiratory and other infections (such as syphilis).

Significantly more infants born in the Almshouse died as a result of a premature birth than those admitted after birth or those born in the city of Buffalo (Federal Census 1890). Deaths due to starvation were higher among both groups of infants at the Almshouse than among infants born in Buffalo. However, the frequency of deaths due to gastrointestinal infections was highest among infants admitted after birth.

This study suggests that poverty was particularly devastating for infants in Erie County, New York, particularly those born at the Almshouse. Also, it appears evident that prenatal care at the Almshouse was not adequate, often resulting in death due to complications of premature birth. This research was supported in part by NSF grant SBR9523533.

Prospective, 3-Year Study of the Effects of Estrogen on Oral and Postcranial Bone Change. C.F. HILDEBOLT, T.K. PILGRAM, N. YOKOYAMA-CROTHERS, M. DOTSON, J. MUCKERMAN, J. HAUSER, S. COHEN, E. KARDARIS, M. VANNIER, R. CIVITELLI (Washington Univ., St. Louis), J. HANES, M. SHROUT (Medical College of Georgia, Augusta).

The objectives of this 3-year prospective study of 134 postmenopausal women (mean age =  $59.9 \pm 5.9$ ) were to measure and test for correlations alveolar and postcranial bone change and to determine whether rates of change were affected by hormone replacement therapy (HRT, estrogen/progesterone). All women were in good medical

and dental health. Half were assigned HRT and half placebo. All women received daily supplements of calcium (1000 mg) and vitamin D plus annual dental prophylaxes and oral hygiene instructions. Alveolar crest height (ACH) and alveolar bone mass (ABM) were determined from digital images of dental radiographs. Bone mineral densities (BMDs) of the lumbar spine and proximal femur were determined with dual energy x-ray absorptiometry. Multivariate analysis of variance, correlation analysis, and t tests were used to analyze the data for 81 women, who had completed the study and had no missing data at the end of year 3.

Over the 3-year study, all women had significant gains in ACH, ABM, and BMD ( $p < 0.003$ ). Differences in BMD depending upon drug arm were significant only at the trochanteric and intertrochanteric postcranial sites ( $p \leq 0.01$ ) and for Total BMD, which is the sum of the neck, trochanteric and intertrochanteric sites ( $p = 0.007$ ). For total, the mean gain in the HRT arm ( $n = 45$ ), was  $0.028 \text{ gm/cm}^2$  (3.8%) and that for the placebo arm ( $n = 36$ )  $0.003 \text{ gm/cm}^2$  (0.7%). ACH and ABM also increased; however, the increases were similar in both arms of the study and were not significantly different. ACH increased by 0.16 mm (6.5%) in the estrogen arm and 0.14 mm (6.3%) in the placebo arm ( $p=0.73$ ). The mean increase in ABM in the estrogen arm was 1.9% and 1.7% in the placebo arm ( $p = 0.75$ ). The correlations between changes in BMD and ACH/ABM were weak ( $r \leq 0.26$ ,  $p \geq 0.06$ ). In conclusion, while the gain in BMD can be attributed to HRT, the gain in alveolar bone cannot. It is likely that the gain in alveolar bone is due to improved dental care and calcium supplementation. The gain in alveolar bone may have confounded our ability to find significant effects for HRT on oral bone.

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Age, sex and resource transport in Venezuelan foragers. C.E. HILTON and R.D. GREAVES\*, Depts. of Anthropology, University of New Mexico, Albuquerque, NM 87131, and \*Southern Methodist University, Dallas, TX 75275.

Enhancing our understanding of the skeletal biology of modern hunter-gatherers and developing more sophisticated models of fossil and prehistoric hominid locomotor behavior and subsistence activities requires information on male and female forager mobility patterns. Unlike other primates, modern human foragers expend considerable energy in activities involving the transport of resources across the landscape. Although forager males are often associated with high mobility in comparison to their female counterparts, forager females are seen to engage in subsistence tasks incorporating a high frequency of burden carrying. This behavior is especially pervasive among older females. This paper examines the influence of age and sex on mobility and resource transport in a group of modern human foragers.

Ethnoarchaeological and biological data were collected during an 18 month study in the Pumé Indian community of Doro Ana located in the savanna-wetlands of southwestern Venezuela. The study group consists of individuals who do not rely upon any form of transportation technology. Hunting, fishing, root collecting, and raw material

acquisition trips ( $n > 100$ ) are analyzed in relation to distances traveled, time allocation, and burdens carried. These behavioral data are combined with controlled measurements of normal and burdened walking in adult males ( $n=22$ ) and females ( $n=23$ ) in order to calculate an "effort" index.

Comparative analyses indicate significant sex differences associated with burden carrying and mobility. While males, on average, walk significantly greater distances, females transport significantly heavier resource loads. In numerous foraging trips, females carried resources exceeding 40% of their body weight. Two-way ANOVAs also indicate that, as a group, older females ( $>35$  yrs) carry significantly heavier burdens relative to their body weight than other age-sex categories. This study suggests that female work effort associated with resource transport increases with age.

Associations between non-dietary variables and anthropometric indices in low-income U.S. urban Latino children. D.A. HIMMELGREEN, University of South Florida, Tampa, FL 33620, R. PEREZ-ESCAMILLA, University of Connecticut, Storrs, CT 06269 and Y. PENG, Hispanic Health Council, Hartford, CT 06106

Socioeconomic, demographic, food assistance, dietary intake, and anthropometric data were collected on a convenience sample of 248 low-income Latino children (1-6 yrs) and their primary caretakers from Hartford, CT. Participants were recruited from community-based agencies, pediatric clinics, churches, and a WIC office.

Compared to U.S. child age-and-sex-specific reference data (NCHS growth curves, using Epi-Info, v. 6 software), close to 11% of the study children were  $\leq 5^{\text{th}}$  percentile for height-for-age and 17% were  $\geq 95^{\text{th}}$  percentile for weight-for-height (25% were  $\geq 85$  percentile), with no statistically significant differences by sex or age. Multivariate analysis (i.e., forced entry multiple entry logistic regression) was used to examine the association between non-dietary variables and anthropometric indices. Children delivered by Cesarean section ( $OR = 0.32$ ,  $p = 0.03$ ) or whose biological mothers were of shorter stature ( $OR = 0.92$ ,  $p = 0.04$ ) were more likely to have low height-for-age than those delivered vaginally or whose mothers were taller. Children that attended pre-school/kindergarten ( $OR = 5.38$ ,  $p = 0.05$ ) or who lived in smaller households ( $OR = 13.89$ ,  $p = 0.05$ ) were more likely to have high height-for-age ( $\geq 95^{\text{th}}$  percentile). Low weight-for-height was more likely to be found among children whose primary caretakers reported being homeless ( $OR = 2.87$ ,  $p = 0.07$ ). Obesity ( $\geq 95^{\text{th}}$  percentile weight-for-height) was more likely to be found among children whose mothers had BMIs  $\geq 27.3 \text{ kg/m}^2$ , and among those who live in households where food stamps ran out before the end of the month ( $OR = 2.68$ ,  $p = 0.04$ ).

These findings suggest that biological and socioeconomic factors are associated with low and high anthropometric indices among this sample of low-income Latino children. Currently, research in Hartford and Tampa, FL is being conducted to further explore these associations.



Ecological and behavioral correlates of vigilance in brown capuchin monkeys (*Cebus apella*) in Iguazu, Argentina. B.T. HIRSCH, DPAS, SUNY at Stony Brook, Stony Brook, NY 11794.

Current socioecological models of formation and maintenance of primate groups include anti-predator vigilance as a benefit to group living. Several studies have shown a decrease in individual vigilance as group size increases or a decrease in vigilance as the number of close neighbors increases. Two social groups were sampled for correlates of vigilance: life history (age, and sex), ecological (canopy cover, and height), and social (activity pattern, rank, number of neighbors within 20m, position in group, group speed, and total group spread). I defined vigilance as looking away from immediate substrates, with or without head movement. I was not able to determine the target of most bouts. I tested the possible functions of vigilance by comparing observed patterns versus predicted patterns according to two major hypotheses: social monitoring and anti-predator vigilance. Monkeys that were nursing and resting had the highest levels of vigilance. During moving and ingesting I observed intermediate levels of vigilance, which decreased when the group foraged more rapidly. While searching substrates and grooming the lowest levels of vigilance were found. Vigilance decreased with distance from the ground and increased with increasing density of neighbors within 20m. After controlling for density of neighbors, neither position in the group nor group spread was correlated with vigilance. This result suggests that social monitoring is a major function of vigilance in this capuchin population. Predation pressure in this study area may be so low that it has little effect on the vigilance levels of capuchin monkeys, and thus may not be an important factor in determining group size.

Genetics of expression of two dental traits in baboons. L.J. HLUSKO and M.C. MAHANEY. Penn State University and Southwest Foundation for Biomedical Research, San Antonio, Texas.

Two molar crown morphological variants, the maxillary interconulus and mandibular interconulid, are commonly considered to be remnants of the primate cingulum. If so, their expression should be influenced by the same genes and environmental factors. We report the results of statistical genetic analyses to 1) assess the extent to which genes influence normal variation in the expression of these two traits, and 2) determine if the same genes influence their expression both within and between dental arches.

Using a scoring system modeled after Turner et al.'s dental scoring plaques for humans, we assessed 2<sup>nd</sup> permanent molar (M2) interconulus and interconulid expression with dental casts from 330 pedigreed baboons (*Papio hamadryas*) resident at the Southwest Foundation for Biomedical Research. Traits were scored from 1 (no expression) to 5 (maximum expression). We

used a maximum likelihood variance decomposition approach to estimate the proportion of the phenotypic variance in trait expression due to the additive effects of genes (heritability or  $h^2$ ) for each tooth, and a bivariate extension of this method to estimate the intra- and inter-arch correlations in degree of expression due to the additive effects of genes ( $\rho_G$ ) and non-genetic factors ( $\rho_E$ ). Trait expression for all four molars was significantly heritable ( $p \leq 0.01$ ), ranging from  $h^2 = 0.17$  (RM2) to  $h^2 = 0.43$  (LM2). Within each arch  $\rho_G = 1$  ( $p < 0.0005$ ), indicating that variation in *bilateral* expression of these two traits is due to shared additive effects of the same genes (i.e., pleiotropy). Because genetic correlations *between* arches differed significantly from 1 ( $p < 0.02$ ; RM2  $\rho_G = 0.53$ , LM2  $\rho_G = 0.72$ ), a significant proportion of the genetic variance in the degree of expression of the interconulus and interconulid cannot be attributed to the same genes. Similarly, within-arch  $\rho_E$  values were higher than those between arches.

Differences in the magnitudes of intra- and inter-arch pleiotropy suggest that overlapping but non-identical sets of genes influence the degree of expression of the interconulus and interconulid in the baboon. Further studies are needed to determine the implications of these findings to the development and expression of other dental traits.

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Transverse masticatory movement and symphyseal fusion: evidence from artiodactyl occlusal wear facets. A.S. HOGUE<sup>1</sup> & M.J. RAVOSA<sup>1,2</sup>. <sup>1</sup>C M Biology, Northwestern University Medical School, Chicago, IL 60611, <sup>2</sup>Mammals, Field Museum of Natural History, Chicago, IL 60605.

Based on a rich history of comparative and experimental research, two mechanical factors have emerged as the likely determinants of primate mandibular symphyseal fusion: dorsoventral shear and "wishboning" (Ravosa & Hylander, 1994). In a new twist, Lieberman & Crompton (in press) argue that increased dorsoventral shear, arising from greater balancing-side muscle force recruitment, plays no role in symphyseal fusion. Rather, they contend that fusion arises as a mechanism to stiffen the mandible to facilitate more efficient transverse movement during occlusion.

According to this scenario, fusion should be found in taxa that have placed a greater emphasis on this component of mastication. Assuming that tooth form can be used as a reliable indicator of jaw movements, Lieberman and Crompton predict that taxa with fused symphyses will have more transversely oriented occlusal wear facets. While their initial data appear to support this notion, the purpose of our study was to explore this issue further.

In order to control for phylogeny and potentially confounding differences in tooth morphology, we tested this prediction in a broad sample of selenodont artiodactyls, a group of closely related animals that vary in symphyseal fusion but exhibit similar molar morphology. Specifically, we compared occlusal wear facet orientation of upper and lower M2's, measured relative to the occlusal plane, in 44 species (217 individuals) from 41 genera and 6 families: 4 camelids, 1 tragulid, 1 graffid, 9 cervids, 28 bovids, and 1 antilocaprid. ANCOVA and ANOVA were used to test for differences in these and other relevant skull variables.

Although some overlap in species means was found, statistical analyses revealed that both upper ( $p < 0.01$ ) and lower ( $p < 0.05$ ) M2 angles were significantly smaller in the fused group than in the unfused group (Kruskal-Wallis one-way analysis of variance). These results provide additional evidence that fusion and transverse masticatory movements are functionally linked, further securing a place for wishboning as a primary determinant of symphyseal fusion. Contrasts in masseter orientation, molar and corpus dimensions, and anisognathia, as well as the implications of these findings for primates will also be discussed.

Microwear of mandibular canines of late stone age and modern Japanese. T. HOJO, Yahatanisi Mitusada 3-19-5 Kitakyush City 807-0805 JAPAN. e-mail: hojo@msf.biglobe.ne.jp

SEM analyses of dental microwear have revealed the different features on the worn occlusal surfaces of human and non-human specimens. In this study high resolution impressions were made from the occlusal surfaces of the mandibular canines of Late Stone Age and modern people using "President Light Body" polyvinylsiloxane (Coltene/ Whaledent). The sputter-coated epoxy resin casts of canines made from impressions were examined using micrographs of an ABT SX-40A scanning electron microscope at the magnification ranging from 10X to 500X. The mandibular canines of both Late Stone Age and modern people in the Kumamoto seashore district of Japan were heavily worn, and the occlusal surfaces of canines were flat and low under the macroscopic observation. The canines of late stone age people showed many long microstriations, and the number of the microstriations was more than that of the micropits on the labial occlusal surfaces, but on the modern canines the number of the micropits was more than that of the microstriations. As for the microstriations on the labial occlusal unit area of one of late stone age canines the mean length was 271 $\mu$ m ( $N=15$ ,  $\sigma=77.46$ ), and the mean width was about 5 $\mu$ m. As for the microstriations on the labial occlusal unit area of one of the modern canines the mean length was 104.9 $\mu$ m ( $N=10$ ,  $\sigma=18.92$ ), and the mean width was about 3 $\mu$ m. The microstriations of Late Stone Age canines were longer and wider than those of the modern people of the Kumamoto seashore district of Japan. Much of the foods of Late Stone Age people in the Kumamoto seashore district might be shellfish and sardines, because their bodies were buried in large Okinoharu shell mounds. The shellfish and sardines in the foods of the Late Stone Age might be more than those of the modern people. The long and wide microstriations of the Late Stone Age canines might be related to many fine grains of sand in shellfish and small hard bones in sardines. The micropits on the occlusal surfaces of the modern people might be related to hard bones of chickens and other animals in the foods of the modern people. The differences in the features on the occlusal surfaces of canines between the two groups might be related to differences in foods.

**Lower limb epiphyseal vs. diaphyseal morphology of Upper Paleolithic humans: Implications for body mass and activity levels.** T.W. HOLLIDAY, Department of Anthropology, Tulane University, New Orleans, Louisiana 70118 USA.

The robust diaphyses of Pleistocene hominids are said to indicate higher activity levels in these prehistoric humans than among people today. Thus, it could be argued that the prediction of these fossils' body mass from lower limb diaphyseal cortical area (CA) using recent human regressions might lead to erroneously high body mass estimates. This study uses three body mass prediction formulae based on the following features: reconstructed femoral 80% (subtrochanteric) CA, femoral head diameter (FH), and bi-iliac breadth to stature (BIB/St) among Early and Late Upper Paleolithic (EUP and LUP), Mesolithic (MES), and recent Europeans. As found by Ruff *et al.* (1997), body mass predictions derived from these three methods are highly correlated ( $r = 0.66$  to  $0.77$ ), and while body mass estimates predicted from BIB/St are smaller than those based on CA or FH, this result holds for all groups studied, including recent humans.

Gleaning behavioral differences from these data is more difficult, as no significant differences in CA were found among the groups. It has been suggested that the EUP had less robust diaphyses than their LUP counterparts. However, here this result is only obtained when CA is size-standardized to femoral length<sup>3</sup> (Ruff *et al.*, 1993; Trinkaus *et al.*, 1998). This should not be interpreted as evidence for lower activity levels in the EUP, but rather as an artifact of standardization. In fact, Trinkaus and colleagues have recently abandoned this method (Trinkaus *et al.*, 1999), for as Wolpoff (1999) points out, these standardized variables are extremely sensitive to limb length differences, and the EUP have longer limbs than their LUP or MES counterparts. With this in mind, these data seem to indicate that there were few behavioral differences between EUP, LUP, and MES humans, at least in use of the lower limb.

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**Extreme measures of SK 1585 brain endocast: The endocranial capacities of robust australopithecines revisited.** R.L. HOLLOWAY, M.S. YUAN, S. MARQUEZ, D.C. BROADFIELD, & K. MOWBRAY, Department of Anthropology, Columbia University, NY, NY 10027; City University, NYC; AMNH, NYC.; Rutgers University, NJ.

During the 1999 AAPA Meetings, Falk *et al.* modified their previous claim that the cranial capacity of Sts 71 had been inflated, but indicated instead that most of the "robust" australopithecines had inflated cranial capacity

estimates. For example, they claimed that SK 1585 measured 476 cc rather than the 530 cc determined by Holloway in 1972, and suggested far lower volumes for the remaining robust specimens. Each of the above authors (except RLH) were asked to make an endocranial reconstruction of SK 1585 based on their understanding of the neuroanatomy of the original specimen. Reconstructions were made for both hemi- and complete endocranials. The values of the various reconstructions varied between 480 cc to 531 cc for the reconstructions made by Mowbray, Marquez, and Broadfield. Yuan made three reconstructions, purposely altering the choice of midline to provide a range of values. In his reconstructions, choosing a midline roughly 1.5 mm shy of the actual midline gave a minimum value of 495 cc. Deviating the midline 1.5-2.0 mm in excess of its actual placement provided a volume 551 cc. Choosing a midline through the sagittal suture gave a volume of 529 cc. The differences between reconstructions for the missing parts was minimal, strongly suggesting that the differences in values were attributable mostly to choice of a midline.

These results vindicate the earlier value of 530 cc by Holloway, and provide a good visual account of how minor differences in midline choice can effect the volume estimates of brain endocranial reconstructions. We believe that the earlier estimates of other robust australopithecines such as KNM-ER 732, KNM-ER 407, KNM-ER 406, and OH 5 were essentially correct, including Falk's earlier estimate of KNM-ER 407 of 506 cc. OH 5 is slightly inflated, as pointed out by Holloway in 1972.

Female reproductive aging. DJ HOLMAN, KA O'CONNOR  
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Reproductive aging in the human female is characterized by an increased risk of pregnancy loss, a decline in apparent fecundability, and an increase in the variability of menstrual cycles at later ages until menopause. In this paper, we examine the most important biological factors that contribute to these patterns.

The single most important factor in the cessation of ovarian cycles is the exhaustion of ovarian follicles. The way in which follicular depletion is related to other age related changes in ovarian cycle and endocrine patterns is less clear. A model of follicular dynamics is presented in which the increase in variability of menstrual cycles as well as reproductive hormone fluctuations are a direct outcome of the shrinking follicle pool. As the pool becomes smaller, stochastic variations in the number of follicles that initiate growth can lead to periods of ovarian quiescence. Since no follicles are producing estradiol, a rise in gonadotropins is seen at the beginning of the cycle until one or more follicles initiate growth and begin to secrete estradiol.

The age-specific increase in pregnancy loss and decline in fecundability was examined in a nine-month prospective study in rural Bangladesh. Since pregnancies cannot be detected before about the seventh day of gestation, it is not possible to directly measure total fecundability and total

pregnancy loss. Instead we used an etiologic model for the distribution of losses across pregnancy, in which conceptuses fall into chromosomally normal and abnormal subgroups. The results suggest that the age pattern of apparent fecundability largely reflects an increase in early pregnancy loss with age. The proportion of abnormal conceptuses appears to increase with maternal age because of increasing numbers of non-disjunction events as the oocyte completes meiosis following fertilization. Total fecundability remains high and nearly constant until the early 40s when it rapidly approaches zero.

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Behavioral changes in European Upper Paleolithic foragers: evidence from biomechanical analysis of the appendicular skeleton. B.HOLT, Anthropology, University of Missouri, Columbia, MO 65211 and S.CHURCHILL, Biological Anthropology and Anatomy, Duke University, Durham, NC 27708.

Evidence from ecological and archeological data indicates that significant behavioral changes took place during the Late Upper Paleolithic in Europe, including (but not limited to) increased logistical foraging strategies, intensification of resource extraction, broadening of the resource base, rapid development of specialized foraging technology, and changes in residential and logistical mobility. Given their developmental plasticity, long bone diaphyses provide an excellent means by which to study the biological effects of these behavioral changes. Patterns of robusticity in upper and lower limb bones of Early (EUP) to Late (LUP) Upper Paleolithic Europeans were examined using a biomechanical approach. The results from the analysis were interpreted within the context of a diet breadth model.

Results suggest that LUP populations had stronger upper limbs than did their EUP predecessors. Analysis of the lower limbs, on the other hand, indicates that there was no significant temporal change in overall strength. Interestingly, however, there was a significant shape change in lower limb diaphyses, with LUP midshaft femora becoming more circular in cross-section as a result of decreased antero-posterior relative to medio-lateral bending strength. These results confirm archaeological evidence of decreased mobility during the LUP. In addition, the diet breadth model predicts that, as preferred (higher rank) resources become increasingly rare, as was undoubtedly the case during the Last Glacial Maximum, lower ranked resources such as small game and shellfish are added, resulting in expansion of the resource base and higher processing costs. Enhanced upper limb skeletal robusticity and acceleration of technological development in the LUP are likely related responses to resource stress that resulted from the concomitant effects of increased population packing and climatic deterioration at the Last Glacial Maximum.